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COMPREHENSION OF COMPRESSED SPEECH BY ELEMENTARY SCHOOL CHILDREN.

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THE EFFECTS OF FOUR VARIABLES ON THE EXTENT OF COMPREHENSION OF COMPRESSED SPEECH BY ELEMENTARY SCHOOL CHILDREN WERE INVESTIGATED. THESE VARIABLES WERE RATE OF PRESENTATION, GRADE LEVEL IN SCHOOL, INTELLIGENCE, AND AMOUNT OF PRACTICE. NINETY SUBJECTS PARTICIPATED IN THE EXPERIMENT. THE TASK FOR EACH SUBJECT WAS TO LISTEN INDIVIDUALLY TO 50 TAPE RECORDED SENTENCES. IF THE SUBJECT PERFORMED CORRECTLY TO THE COMMAND PHRASED, THE SENTENCE WAS JUDGED TO HAVE BEEN COMPREHENDED. FIVE SENTENCES WERE PRESENTED AT 10 DIFFERENT SPEEDS (WORDS PER MINUTE). A SPEECH COMPRESSOR WAS USED TO COMPRESS SENTENCES TO THE DESIRED RATES. AN ANALYSIS OF VARIANCE SHOWED THE FOLLOWING EFFECTS TO BE STATISTICALLY SIGNIFICANT AT THE .05 LEVEL - RATE OF PRESENTATION, GRADE LEVEL, PRACTICE, THE RATE BY PRACTICE INTERACTION, AND THE RATE BY GRADE LEVEL BY PRACTICE INTERACTION. THE INVESTIGATOR STATED THAT EFFECTS ASSOCIATED WITH RATE AND PRACTICE VARIABLES SHOULD BE INTERPRETED CAUTIOUSLY. ALTHOUGH SENTENCES WERE ASSIGNED RANDOMLY TO RATES, THEIR APPARENT HETEROGENEITY IN TERMS OF INHERENT DIFFICULTY MAY EITHER HAVE CONTRIBUTED TO OR OBSCURED THE RELATIONS BETWEEN THE RATE AND PRACTICE VARIABLES AND COMPREHENSION. (WB)

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COMPREHENSION OF COMPRESSED SPEECH BY ELEMENTARY SCHOOL CHILDREN

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C.D.W.

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CHAPTER I

INTRODUCTION

Although listening is an important aspect of communication, it is an area that has remained relatively unexplored by researchers. The view that it should be of more concern to those interested in the educational process is supported by estimates that over 50 per cent of the class time in the elementary school and almost 90 per cent of the class time in high schools and colleges is spent in listening. (31:3)*

Although research efforts have been few, increasing emphasis is being placed upon listening to verbal material as a channel for instructional communications. Schools are expanding the use of educational broadcasting, of language laboratories, of classroom listening centers, and of other audio distribution systems.

Listening to verbal material, however, has often been considered to be an inefficient way of learning; for the rate at which most people can assimilate such material is much faster than the rate at which it is normally presented in spoken form. This inefficiency has led investigators to devise ways of increasing the rate at which auditory verbal material is presented. However, in the past, techniques used for increasing this rate have generally been such as to lead to distortion of speech sounds, and consequently to reduced comprehension of the material presented.

Recently, a relatively distortion-free technique for increasing the rate of presentation of recorded verbal material has been developed.

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*Numbers in parentheses refer to numbered references in the bibliography; those after the colon are page numbers.

This process, an electro-mechanical one, compresses individual speech sounds in time, thereby increasing the words-per-minute rate of presentation and hence decreasing the time needed to communicate a given message. Research concerned with this new process has shown that comprehension of material by adults and older children is little affected by rather drastic compression. The purpose of the present study was to determine the extent of comprehension of such time-compressed material by elementary school children.

Nature of the Problem

Listening and reading are generally considered the major ways that school children acquire information. These information-receiving skills, along with the information-sending skills of speaking and writing, constitute the greater part of communication in the instructional process.

When young children first enter school, their learning opportunities come largely through their ability to listen; the majority of their classroom time is spent in listening and speaking situations. Only as they learn to recognize and manipulate the visual symbols of the spoken language will the students and their teachers put increasing reliance on reading and writing as communication factors and less reliance on listening.

Even if children recognized and practiced effective listening habits, a supposition that Taylor (31:4) describes as doubtful, the act of listening in school would still be a relatively inefficient use of learning time. Nichols (23:79) has described this problem of listening

inefficiency as one in which the brain is capable of processing messages at a "lightning" pace, whereas normal speech is relatively slow. Thus, time is wasted, for most listeners could comprehend speech at much faster rates than those generally used.

In school, this difference between the rate of presentation and the students' processing of verbal material--this unused listening time--may contribute to inattention. In fact, it may allow time for the student to create distracting ideas that interfere with the effective reception of the teacher's spoken message.

Drastically increasing a teacher's normal classroom speaking rate is not a practical solution to this problem of listening efficiency in the school. However, educational listening opportunities today are not always restricted to those involving direct verbal instruction by the teacher; they may also include such learning activities as listening to instructional tape recordings. Thus, if verbal material that has been tape recorded could be increased in rate of presentation without excessively reducing its comprehensibility, then, a given message could be presented in less time. In other words, increased listening efficiency would be possible.

In the past, attempts to increase the rate of speech either directly or indirectly have been hindered by distortion effects that have restricted intelligibility. Recently, however, an apparently effective method for increasing the rate of presentation of tape-recorded spoken material has been developed. Travers (32) refers to this process, which involves compressing a message in time, as one in which redunancy of sound is removed. The operation of an electro-

mechanical device that is used to achieve such time compression has been described by Foulke as follows:

> The device we use to compress speech is the Tempo-Regulator, manufactured by Telefonbau und Normalzeit, Frankfurt-am-Main, Germany. The Tempo-Regulator samples recorded tape in the following manner. The tape passes over the curved surface of a cylinder and wraps around the cylinder enough to make contact with one quarter of its circumference. Four tape reproducing heads are spaced equally around the circumference of the cylinder. When this cylinder is stationary and the tape is moving at the same speed at which it moved during recording, (15 inches per second), it makes contact with one of the reproducing heads and the signal is reproduced as recorded. When the Tempo-Regulator is adjusted for some amount of compression, the speed of the tape increases and the cylinder begins to rotate in the direction of tape motion. As the speed of the tape is increased, the rotational speed of the cylinder is increased so that the speed of the tape relative to the surface of the cylinder is held constant at 15 inches per second, (ips). Under these conditions, each of the four heads in turn, makes and then loses contact with the tape. Each head reproduces, as recorded, the material on the portion of the tape with which it makes contact. When the cylinder is so positioned that one head is just losing contact with the tape while the preceding head is just making contact with the tape, the segment of tape that is wrapped around the cylinder between these two heads never makes contact with a reproducing head and is therefore not reproduced. The segment of the tape that is eliminated from the reproduction in this manner is always the same length, one quarter of the circumference of the cylinder. The amount of speech compression depends upon the number of such eliminations per unit time, and this in turn depends upon the tape and cylinder speed. Speech may be expanded by reversing the direction of rotation of the cylinder and by moving the tape across the cylinder at a speed slower than that used during recording. (13:4)

Foulke goes on to point out that the Tempo-Regulator referred to above required special adaptations in order to serve adequately as a research tool, but that the function of the unit remained basically as described. For the purposes of this study this adapted Tempo-Regulator will be referred to as a "speech-compressor," a term used by Foulke (14:4).

Thus far, it has been pointed out that listening is an important means of communication in the educational process; that this is particularly true with regard to young children; that tape recordings are one form in which material is presented for listening in the elementary school; that at the usual rate of presentation of speech, listening is not an efficient means of learning; and that recorded speech can be time-compressed electro-mechanically to achieve more efficient use of listening time. Under these circumstances, if time-compressed recordings were available for use in instruction in the elementary school, it would appear that greater listening efficiency might be effected. Orr, Friedman, and Williams (25:16), for instance, have concluded that compressed speech might have educational value in presenting information in less time, in improving aural and reading comprehension skills, and in reviewing material already learned.

However, before compressed speech can make an effective contribution to efficiency in learning, more must be known of its potentiality and of its limitations. Since no prior attempt had been made to identify the ability of normal, young children to comprehend time-compressed speech, such children were chosen as subjects for this study. Thus, the present experiment was designed to determine the extent to which elementary school children in grades 1, 3, and 5 were able to comprehend verbal material that had been compressed to various words-per-minute rates.

Related Research and Literature

This section is divided into three parts as follows: (a) selected resource materials concerned with the broad topic of listening; (b) selected research studies related to listening in education, but not to rate of presentation; and (c) selected research studies related to the effect on listening comprehension of the rate of presentation of verbal material.

Resource materials. Research summaries, reviews of literature, and bibliographies related to the general field of listening are relatively limited in number and scope. In a series of three articles, Witty and Sizemore (37, 38, 39) summarized listening research from 1892 to 1958. Goyer (19) reported on 46 studies and articles. Duker (4, 6) reviewed listening studies in separate issues of the Review of Educational Research. Seeger (29) and Duker (3) prepared unpublished bibliographies. Duker (7) published an annotated, cross-referenced bibliography on listening. Taylor (31) summarized research related to the teaching of listening. Travers (33) reviewed the role of listening in audiovisual communication.

Listening research in education. The need for more research concerned with the listening process in education has been noted by many writers (5, 19, 26, 31). It has been estimated that 90 per cent of the research concerned with listening has been conducted since 1952 (31:3). Among early investigators were Rankin (27), who was interested in developing a reliable listening test and in finding out the extent to which listening was used as a form of communication, and Stump (30), who was

concerned with comparing oral methods with printed methods for presenting test material.

The importance of listening in the elementary school has been pointed out in at least three studies. Wilt (35) found that the pupils she observed in elementary schools spent 57.5 per cent of their classroom time in listening situations. She also found that the majority of teachers did not realize the extent of listening demanded of the school child.

Budoff and Quinlan (1) tested the hypothesis that auditory presentation is often more effective than visual presentation for young children and that this relative effectiveness decreases as the age of the subject increases. They used a paired associates design to compare the aural and visual learning ability of second grade children. The results indicated that aurally presented word pairs were learned more quickly than visual pairs. They concluded that aural learning among second grade children seemed more rapid and more efficient than learning by means of a visual presentation.

Hampleman (20) compared listening and reading comprehension ability of fourth and sixth grade children. The same narrative verbal material was presented either orally or visually to different groups at each grade level. An objective test was used to measure comprehension. The investigator concluded that listening comprehension was significantly superior to reading comprehension at both grades.

Listening comprehension and rate of presentation. There appears to be little agreement as to what constitutes either a normal or a most effective rate of presentation of verbal material. Nichols (23:78) has

stated that the normal rate is about 125 words per minute; whereas Taylor (31:12) has speculated that 135-175 words per minute is a normal range, with 150-175 words per minute being the rate preferred by most listeners. According to Travers (33:2.77), the most effective speed in terms of comprehension is about 160 words per minute. Foulke (14:3) has stated that the normal oral reading rate is approximately 175 words per minute.

Two of the early studies concerned with the effect of changes in rate of presentation were those of Goldstein (18) and Nelson (22). Both investigators used adult subjects and achieved changes in rate through altering speaking speed. Goldstein compared reading comprehension with listening comprehension when identical material was presented aurally or visually at rates between 100 and 322 words per minute. He found listening superior at rates between 100 and 211 words per minute, equal at 248-285 words per minute, and inferior at 322 words per minute. There was a steady decrease in effectiveness from 100 to 322 words per minute. Nelson's results were similar in that a steady decrease in comprehension occurred as the spoken rate increased from 125 to 225 words per minute. However, these differences were not significant within this range.

Another study based on changes in speaking speed was conducted by Fergen (12). She used children from the fourth, fifth, and sixth grades as subjects. The rate was varied from 80 to 230 words per minute in increments of 50 words. Her material consisted of selections from a standardized reading test which were adapted for oral presentation and were read and recorded at the selected rates. Comprehension was measured by a written test. The results showed that at all grade levels the rate of 130 words per minute resulted in maximum scores, that 80 words per

minute was superior to 180 words per minute, and that 180 words per minute was more effective than 230 words per minute. She also found a consistent increase in comprehension at all rates from the fourth through the sixth grade, but found no basic differences in comprehension pattern between the upper (M = 119.24) and the lower (M = 83.53) intelligence quartiles.

All three of the studies just cited were dependent for rate change upon the ability of the narrators to speak more rapidly or slowly. Garvey (16:102) has pointed out that the use of such a technique for varying rate may affect timing and enunciation to the detriment of comprehension by the listener.

In an attempt to overcome the limitations noted by Garvey, two technical alternatives for achieving changes in speech patterns were developed; these were the "interruption" and the "chop-splice" processes. Miller and Licklider (21) employed the former in studying speech intelligibility. By turning a switch on and off automatically at various rates from 10 to 10,000 times per second, they interrupted the speech pattern of monosyllabic words. This technique did not involve any saving in time, i.e., there was no compression, but their results did show that there appeared to be an excess of auditory cues in the words tested. If the interruption cycle were rapid enough, as much as 50 per cent of a sound could be deleted without affecting intelligibility.

The forerunner of the electro-mechanical speech compression method was Garvey's "chop-splice" technique (16). Using college students as subjects, and spondaic words as his material, he magnetically recorded each word on tape and then manually cut (chopped) segments from the tape at regular intervals. The remaining sections were then united (spliced)

to form a new and continuous, compressed unit. The results disclosed that 90 per cent or better intelligibility of words was maintained when as much as 60 per cent of a word was removed.

In a further analysis of the results of the above study, Garvey (17) found that for most words, there was relatively little consistency in accuracy among subjects. Also, he found that compressed, consonant phonemes were responded to erroneously more often than were compressed vowel phonemes.

The results of the studies just cited showed that it was possible to interrupt or compress speech sounds rather drastically and still maintain intelligibility or comprehension. They also emphasized the need for improved techniques for altering the rate of presentation of recorded material.

Shortly after Garvey's results involving the use of the manual, time-consuming, chop-splice technique were reported, Fairbanks, Everitt, and Jaeger (9) described a way of automatically compressing recorded material though the use of an electro-mechanical device. This new development greatly simplified the task of obtaining time-compressed material and led to additional studies.

Working with Air Force trainees and using the new time-compression device to prepare material, Fairbanks, Guttman, and Miron (10) investigated the relationship between the extent of comprehension of factual details in two spoken messages and the rate at which the messages were heard. The time-compressed messages were presented at rates from 141 to 470 words per minute. Comprehension was measured with a 60-item objective test. The mean number of items correct at each words-per-

minute rate was found to be as follows: at 141 wpm, 38.3; at 201 wpm, 35.9; at 282 wpm, 34.8; at 353 wpm, 27.8; and at 470 wpm, 15.7. As can be seen, at 282 words per minute, comprehension was 90 per cent of that at 141 words per minute, and the material had been presented in one-half of the time.

In another study, the same authors (11) evaluated the effects of listener aptitude and message effectiveness. They concluded that time compression, listener aptitude, and message design all affected comprehension.

Fairbanks continued to explore the time-compression process. He worked with Kodman (8) to study the intelligibility of monosyllabic words which had been time-compressed with varying degrees of discard interval and sampling frequency. They used young adults as subjects. Words were presented at 40-90 per cent compression. The investigators found that with the extent of compression held constant, as the discard interval increased in length from 0.01 to 0.24 second, intelligibility decreased. At each level of discard interval, as compression increased, intelligibility decreased. Maximum intelligibility was reached at sampling intervals between .01 and .1 second at compression amounts of 50 per cent, 75 per cent, and 87.5 per cent.

For almost five years no further studies using time-compressed material were published. Then Foulke and others (15) reported the results of a study using time-compressed material with blind children. The speech-compressor described earlier in this paper was used to accomplish time-compression, and comprehension was tested at rates from 175 words per minute to 375 words per minute. Two recorded passages,

one scientific, the other literary, were presented to blind children in grades six through eight. A 36-item objective test was used to measure comprehension. The mean number of items correct for the various rates of presentation of the scientific material were as follows: at 175 wpm, 20.12; at 225 wpm, 18.69; at 275 wpm, 18.55; and at 325 wpm, 16.17. (The scientific material was not presented at 375 words per minute.) For the literary material the scores were as follows: at 175 wpm, 25.80; at 225 wpm, 24.74; at 275 wpm, 24.21; and at 325 wpm, 16.24.

It can be seen in the case of both passages that at 275 words per minute better than 90 per cent comprehension occurred. Foulke concluded that the test scores alone did not reveal the full educational importance of the experiment. He felt that the time saved in presenting the material was important, especially since the same material was found to be read in braille at only 57 to 70 words per minute.

Orr, Friedman, and Williams (25:15) reported that their research showed that college students could comprehend compressed speech at 325 words per minute with only slight loss in comprehension.

It would appear, based on the findings of Fairbanks et al. (10), Foulke et al. (15), and Orr et al. (25) that a high degree of comprehension can be expected when compressed speech is presented to naive listeners at rates of from 275 to 325 words per minute.

Although the results of experiments concerned with training subjects in listening to compressed speech are not conclusive, it appears that higher effective rates are possible when subjects have had some prior exposure to increased rates. Voor (34), for instance, found that subjects exposed to material at 380 words per minute improved in

comprehension with practice. Orr (24:460) has indicated that with a small amount of training, a rate of 425 words per minute can be used with 80 per cent comprehension. Foulke (13), on the other hand, found that neither of two different methods of training resulted in significant increases in comprehension at 350 words per minute.

In two additional studies, Foulke (13) found (a) that retention of compressed speech material followed a pattern similar to that for retention of material delivered at normal rates, and (b) that differences between reading style and voice quality of narrators affected the comprehension of normal and fast rates in like manner.

Research Objectives

The purpose of this study was to determine the ability of elementary school children to comprehend compressed speech. The effects of four independent variables on comprehension were investigated. These were rate of presentation, grade level, intelligence classification, and amount of practice.

One measure of listening efficiency is the amount of verbal material that can be comprehended in a given time. As speech compression allows more material to be presented in a given time, the effects on comprehension of different words-per-minute rates of presentation has been an important consideration in previous research. The determination of such effects in young children was the primary objective of the present study.

Children's efficiency in reading, computation, and other learning skills usually increases as they progress through elementary school. It

was not known whether this growth pattern also applied to their ability to comprehend compressed speech. Thus, an objective of the present study was to find and compare differences in comprehension, if any, by children at the first, third, and fifth grade levels.

In verbal learning situations it is a well-established finding that intelligence is a factor that affects the degree of success. Prior research has shown that the amount of comprehension of compressed speech by adults is positively related to level of intelligence. In the present study, this relationship was investigated in young children.

Although students may initially have difficulty in comprehending compressed speech, they may nevertheless have less difficulty after they have had some training. The design of the present study was such as to allow a determination of whether the subjects' comprehension improved during the course of an experimental session.

In addition to the main effects of the four variables described above, the two-, three-, and four-way interactions among them were examined. Only four of these interactions were considered of primary interest, and these correspond to the following questions: (a) Does the variation in comprehension as a function of rate of presentation differ from one grade level to another? (b) Does the variation in comprehension as a function of intelligence classification differ from one grade level to another? (c) Does the variation in comprehension as a function of rate of presentation differ from one intelligence classification to another? (d) Does the difference from one intelligence classification to another in the variation in comprehension as a function of rate of presentation differ from one grade level to another?

Altogether there were fifteen experimental effects. Eight of these were considered of primary interest and comprised the research objectives just described.

CHAPTER II

METHOD

Subjects for this experiment were public school pupils selected with respect to grade level and intelligence quotient. Tape-recorded, imperative sentences, time-compressed at rates from 175-400 words per minute were used as stimuli.

The experimental task was for the subject to listen to a stimulus sentence and then respond to it. If the subject performed as directed in the stimulus sentence, he was judged to have comprehended the sentence at the words-per-minute rate of presentation.

Subjects

Ninety subjects participated in the experiment. They were boys and girls from the first, third, and fifth grades at the Elementary School, Division of University Schools, Indiana University, Bloomington, Indiana. Prior to selection of subjects, the California Test of Mental Maturity, Form 57-S, was administered to the 112 first graders, the 94 third graders, and the 90 fifth graders. This gave an intelligence quotient for each child.

Based upon the I.Q. data, three pre-experimental groups of 16 children were formed at each grade level. Selection of these 48 children at each grade level was such that the three groups were maximally separated in terms of group I.Q. means within each grade, but such that the mean I.Q. for a given group at each grade level was approximately equal to the mean I.Q. for corresponding groups at the other two grade levels.

These 144 children were given hearing tests under the direction of an audiometrist. On the basis of these tests, four of the children were withdrawn from the nine pre-experimental groupings, two from one group and two from another.

Then, at each grade level ten children were selected at random from each of the three pre-experimental I.Q. groups. These thirty children at each grade level became the ninety subjects for the experiment. The mean the standard deviation, and the range of I.Q. for each of the nine groups in the experiment are shown in Table 1.

TABLE 1. MEAN, STANDARD DEVIATION, AND RANGE OF I.Q. SCORES FOR EACH OF THE NINE GROUPS FORMED FOR THE STUDY

Grade level	Intelligence classification		
	Very superior*	Superior*	Average*
1	Mean: 133.5‡ S.D.: 1.70 Range: 131-137	Mean: 116.7 S.D.: 1.08 Range: 115-118	Mean: 94.8 S.D.: 2.79 Range: 94-102
3	Mean: 132.5 S.D.: 2.68 Range: 129-136	Mean: 116.7 S.D.: .29 Range: 115-118	Mean: 98.8 S.D.: 1.80 Range: 96-101
5	Mean: 132.6 S.D.: 4.76 Range: 127-143	Mean: 116.4 S.D.: 2.28 Range: 112-119	Mean: 98.8 S.D.: 1.95 Range: 96-101

*Classification titles are based upon the quality classifications for I.Q. used with the California Test of Mental Maturity, Form 57-S, with the exception that the single designation "average" is used in place of the classification "high average" and "low average."

‡Each of the entries in the table is based upon the I.Q. scores of ten subjects.

Stimuli

At the time of the study, apparently no standardized listening test had been designed to be used at all of the grade levels involved in this experiment. Therefore, it was necessary to develop special material to measure listening comprehension. Tests dependent upon reading and/or writing ability to indicate listening comprehension were deemed inappropriate because of the wide range in these abilities to be expected among children in grades one, three, and five. Hence, a testing method reported by Schlanger (28) that did not require reading or writing skills was adapted for this study. This method involved presenting a subject with a number of sentences, each of which directed him to perform a simple, specific task. If he performed the task as directed, he was judged to have comprehended the sentence.

Such a concept of comprehension appeared to be in agreement with that suggested in a statement made by a Joint Committee of the Association for Childhood Education International, the Association for Supervision and Curriculum Development, the International Reading Association, and the National Council of Teachers of English (2:8). This statement was to the effect that a child may reveal what he understands from listening by the way he responds to directions.

Fifty-seven simple, imperative sentences requiring a variety of overt responses were developed. They were then recorded at approximately 175 words per minute. These sentences were tested on two five-year-old children, three seven-year-old children, and one ten-year-old child. Fifty-four of the original sentences were judged by the experimenter to

elicit correct, readily discriminable responses. As the responses did not seem to require fine discriminations in order to judge the occurrence of comprehension, it was not felt necessary to test the material with additional judges.

Four of the fifty-four sentences were chosen at random to be used during the instruction of subjects. The remaining fifty became the stimuli for the experiment.

The words-per-minute rates to be used in the study were selected with respect to those used in previous studies of compressed speech, and with respect to the compression capability of the equipment to be used. From a base rate of 175 wpm, rates were chosen in increments of twenty-five words per minute up to a maximum of 400 wpm--a total of ten different rates. The extent of compression is defined as the percentage of the original listening time that is eliminated, i.e., 0 per cent for 175 wpm, 13 per cent for 200 wpm, 22 per cent for 225 wpm, 30 per cent for 250 wpm, 36 per cent for 275 wpm, 42 per cent for 300 wpm, 46 per cent for 325 wpm, 50 per cent for 350 wpm, 53 per cent for 375 wpm, and 56 per cent for 400 wpm.

It was assumed that any differences in the inherent comprehensibility of the various imperative sentences would be of negligible consequence, and that random assignment of sentences to compression rates would negate any minor differences. Accordingly, the fifty sentences were randomly assigned to the ten words-per-minute rates of presentation with the restriction that five sentences be assigned to each rate. The four instructional sentences were given arbitrary rate assignments.

In preparing the stimuli, each sentence was read aloud by a male narrator at a rate of approximately 175 wpm and recorded on magnetic tape. After each sentence was recorded, the tape was rewound and played back. During this playback the sentence was timed by a stop watch. If, in the judgment of the experimenter or the audio technician, there was a discrepancy in the desired rate of greater than approximately $\pm$15 wpm, or a flaw in voice quality or clarity, the sentence was narrated and re-recorded. Upon completion of the recording of the fifty-four sentences at approximately 175 wpm, each one was time-compressed to its assigned rate.

In order to measure any practice effect that might occur during the course of the experiment, five practice blocks of ten sentences each were established, with each rate being represented once in each block. The order of rates within blocks and the assignment of time-compressed sentences to each block was randomized. Sequencing of the introductory material was arbitrary.

Following time-compression, the sentences were cut from the recording tape and assembled in stimulus-response units composed of the following three parts: (a) pre-stimulus interval--a one-second tape segment of a pre-recorded 500 cps tone followed by a one-second segment of non-recorded, silent leader tape, (b) stimulus--a time-compressed sentence, and (c) response interval--a seven-second segment of non-recorded, silent leader tape. These parts were spliced together as a unit.

When all the stimulus-response units were completed, they were spliced together in the predetermined order for rates and practice

blocks and a master tape copy was made of these assembled units. This master copy included the sentences to be used as a part of the instructions to subjects (see Appendix A) as well as the sentences to be used during the experiment proper (see Appendix B).

A pilot study, using the master copy of the instructions and the stimulus material, was conducted with three second-grade and three fourth-grade children. This study revealed no problems relating to the administration of the experiment or in the determination of the correctness of the responses of the subjects to the stimuli.

Apparatus

The stimulus material for the experiment was recorded in the sound studio of the Audio Department, Audio-Visual Center, Indiana University. It was recorded at 15 ips, full track, and the recording was supervised by an audio technician. An Ampex tape recorder, model 351, and a Neumann microphone, model KM-56 were used.

Time-compression was done using the speech-compressor at the Performance Research Laboratory, University of Louisville, Louisville, Kentucky, and was supervised by Dr. Emerson Foulke. The time-compressed material was recorded from the speech-compressor at 7.5 ips, full track, on a Crown tape recorder, model 800.

The master tape for use in the study was prepared at the Audio Department, Indiana University, and copies for the experiment were made at 7.5 ips, full track, using Ampex tape recorders, model 351.

During the experiment a monaural Roberts tape recorder, model 192-HT, was used to play the recorded material. The subject and the experimenter listened through Lafayette headphones, model F-767, which were connected to the 8 ohm output of the recorder through a Lafayette junction box, model F-641. During the 500 cps tone interval the output of the subject's headphone, with 0.0002 microbar as reference, was approximately 92 db, as measured by the Electronics Department, Indiana University.

Procedure

The experiment was conducted during the regular elementary school hours in an unoccupied classroom at the University Elementary School, Bloomington, Indiana.

The subject and the experimenter were facing each other about six feet apart. Each was seated at a small table. The experimenter had available a tape recorder, pre-recorded tape, two headphones, individual data recording forms with each subject's name and I.Q. already entered, and pencils.

Subjects took part in the experiment individually, with approximately fifteen minutes being required for each session. The order of grade levels, classes, and subjects was not experimentally controlled.

After each subject was seated he was asked his name; then the time and date were entered on his data recording form. He was instructed in the task and during this time was presented examples of compressed speech by means of the tape recorder speaker, and through headphones. (See Appendix A.) Immediately thereafter, the experiment began.

At all times that the subject was using headphones, the experimenter monitored the tape recorder output through similar headphones. The internal speaker of the tape recorder was automatically disconnected when the headphones were in use.

During the experiment, the subject listened by means of headphones to a tape recording of fifty imperative sentences compressed at rates from 175-400 wpm. (See Appendix B.) Each sentence was included in a stimulus-response unit containing three parts, as explained previously under the topic of Stimuli. Each unit followed immediately after the preceding one, and the order was the same for all subjects.

The subject's task was to respond to each sentence he understood by performing as commanded in the sentence. The experimenter observed each response and recorded it on the data form as either correct or incorrect (a lack of response was considered to be an incorrect one). A correct response was considered an indication that comprehension of the stimulus had taken place. When the experiment was concluded, the subject was thanked for his assistance and then returned to his class.

Design

The design of the study is described by Winer (36) as being a multifactor experiment having repeated measures. Intelligence and grade level, with three levels each, were "between subjects" factors. Rate and practice blocks were "within subjects" factors, with ten levels of the former and five of the latter. The design of the study is represented in Table 2.

TABLE 2. EXPERIMENTAL DESIGN

Practice block	Rate (wpm)	Grade 1 (30)*			Grade 3 (30)			Grade 5 (30)		
		A‡ (10)	S▲ (10)	V# (10)	A (10)	S (10)	V (10)	A (10)	S (10)	V (10)
I	375	**								
	225									
	400									
	175									
	350									
	200									
	300									
	275									
	250									
	325									
II	375									
	175									
	275									
	325									
	350									
	400									
	300									
	225									
	250									
	200									
III	325									
	250									
	175									
	275									
	375									
	300									
	350									
	225									
	200									
	400									

*Figures in ( ) represent number of subjects in each category.

‡Average intelligence classification.

▲Superior intelligence classification.

#Very superior intelligence classification.

**Ss in each category were tested once at each rate in each block.

TABLE 2 (Continued)

Practice block	Rate (wpm)	Grade 1 (30)			Grade 3 (30)			Grade 5 (30)		
		A (10)	S (10)	V (10)	A (10)	S (10)	V (10)	A (10)	S (10)	V (10)
IV	225									
	350									
	400									
	200									
	175									
	325									
	375									
	275									
	250									
	300									
V	400									
	200									
	225									
	350									
	325									
	275									
	250									
	300									
	375									
	175									

CHAPTER III

RESULTS AND DISCUSSION

Results were based upon responses made by subjects to the presentation of 4,500 samples of compressed speech. An analysis of variance was applied to the results and is summarized in Table 3. An assumption underlying the use of this analysis is that each of the error terms used be made up of sources of variation that are homogeneous. In the present case, there was evidence based on the F_{max} statistic (36) that this assumption was not justified in the case of each of the four error terms that were used. However, the magnitude of the departure from the assumption was small enough that it seemed advisable to proceed with the analysis. The "robustness" of the F test in the case of minor deviations from its underlying assumptions has been pointed out by a number of writers (e.g., 36:93). The decision was made to adopt a critical region for rejecting null hypotheses corresponding to the 5 per cent level of significance. The results in terms of the eight primary research objectives were as follows.

TABLE 3. SUMMARY OF ANALYSIS OF VARIANCE

Source of variation	SS	df	MS	Required .05 value	F
Between subjects					
A (grade level)	8.08	2	4.04	3.11	28.86*
B (intelligence)	.82	2	.41	3.11	2.93
AB	1.21	4	.30	2.48	2.14
Subjects within groups [error (between)]	11.26	81			
Within subjects					
C (practice block)	6.53	4	1.63	2.40	27.16*
AC	.28	8	.04	1.97	.67
BC	.48	8	.06	1.97	1.00
ABC	.80	16	.05	1.68	.83
C x Ss within groups [error (within)]	18.43	324	.06		
D (rate)	33.07	9	3.67	1.90	73.40*
AD	7.33	18	.41	1.61	8.20*
BD	1.05	18	.06	1.61	1.20
ABD	1.85	36	.05	1.44	1.00
D x Ss within groups [error (within)]	39.12	729	.05		
CD	101.07	36	2.80	1.43	56.00*
ACD	9.53	72	.13	1.29	2.60*
BCD	3.07	72	.04	1.29	.80
ABCD	8.72	144	.06	1.21	1.20
CD x Ss within groups [error (within)]	148.29	2916	.05		

*Significant at .05 level of confidence.

Results

Rate of presentation effect. As shown in Figure 1, the total number of errors at each of the ten words-per-minute rates of presentation was: 175 wpm--3; 200 wpm--5; 225 wpm--16; 250 wpm--1; 275 wpm--69; 300 wpm--60; 325 wpm--36; 350 wpm--40; 375 wpm--111; and 400 wpm--104. Stated in terms of percentage of responses that were correct, the results were as follows: 175 wpm--99.33 per cent; 200 wpm--98.89 per cent; 225 wpm--96.45 per cent; 250 wpm--99.78 per cent; 275 wpm--84.67 per cent; 300 wpm--86.67 per cent; 325 wpm--92.0 per cent; 350 wpm--91.12 per cent; 375 wpm--75.33 per cent; and 400 wpm--76.89 per cent.

The difference between rates with respect to mean number of errors over all subjects was statistically significant. Thus, it may be stated that comprehension varied significantly as a function of rate of presentation.

Although there was a general increase in errors as rate of presentation increased, the function was not very orderly. As each subject was tested, the experimenter kept brief notes of unusual overt reactions to the compressed sentences. An analysis of these notes has revealed additional data about three of the rates of presentation--viz., 275, 300, and 375 wpm. At each of these three rates a large number of subjects appeared to comprehend in part a certain one of the compressed sentences; however, as the response was not completely accurate in these cases, it was scored as an error.

One of these three sentences, Number 17, "Bite your finger easily," was presented at 275 wpm in practice block II. In response,

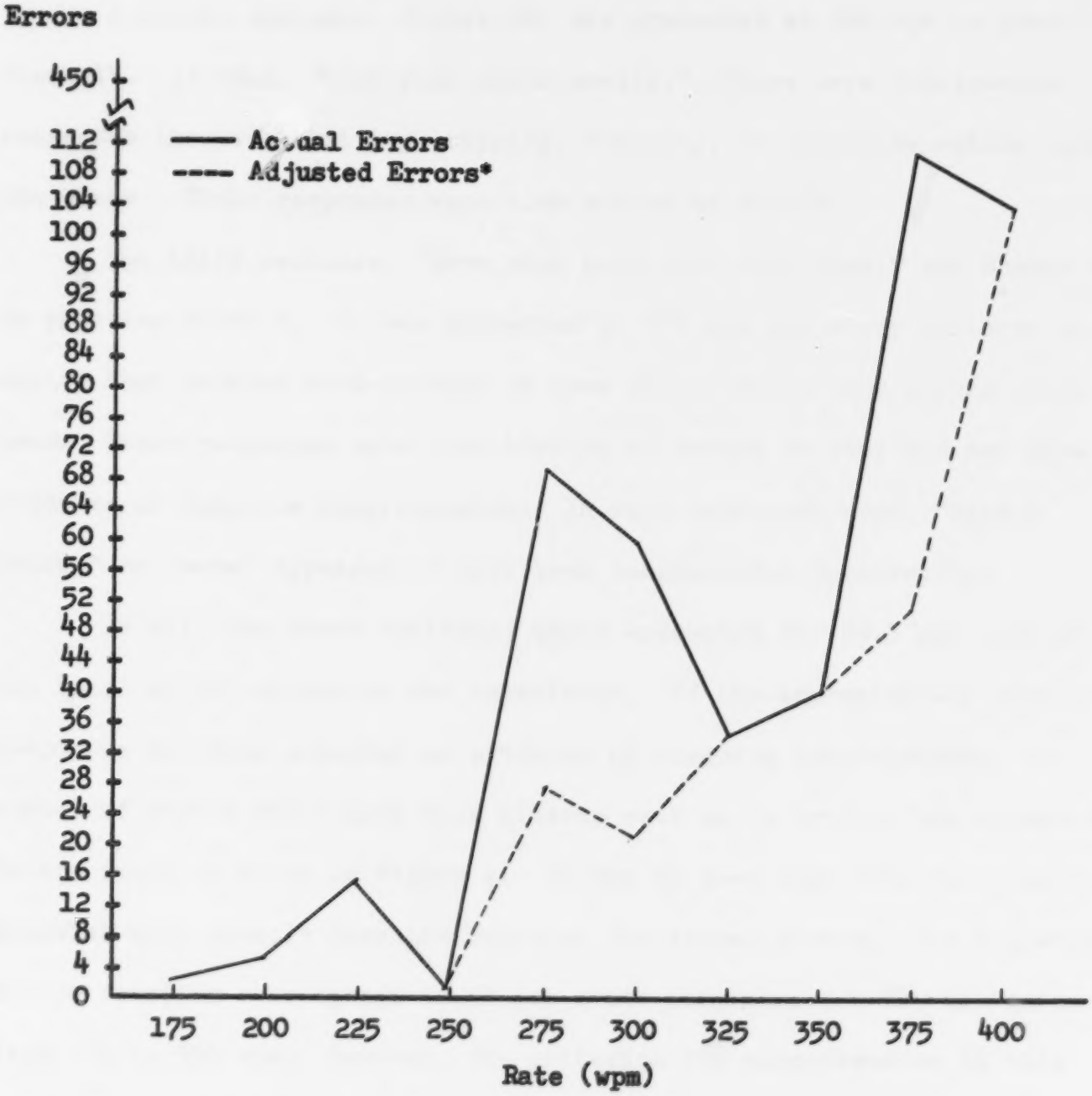

Figure 1. Performance as a Function of Rate of Presentation

*See text for explanation of "Adjusted Errors."

forty-one subjects either bent, bumped, or moved their finger in some definitely finger-oriented action but were scored as not having comprehended the sentence.

A second sentence, Number 38, was presented at 300 wpm in practice block IV. It read, "Kick your chair easily." There were thirty-nine responses involving hitting, tipping, touching, or otherwise acting upon the chair. These responses were also scored as errors.

The third sentence, "Wave your hand over your head," was Number 49 in practice block V. It was presented at 375 wpm and sixty children took action that related head-to-hand in some manner other than waving over-head. These responses were also treated as errors as they did not show evidence of complete comprehension. In each case, one word, "bite," "kick," or "wave" appeared to have been comprehended incorrectly.

In all, the three sentences above accounted for 39.5 per cent of the total of 445 errors in the experiment. If the approximately correct responses had been accepted as evidence of adequate comprehension, the number of errors would have been altered such as to produce the Adjusted Errors function shown in Figure 1. It may be seen that this function is somewhat more orderly than the function for Actual Errors. The Adjusted Errors function corresponds to 90 per cent+ comprehension for all rates from 175 to 350 wpm. However, the criterion for comprehension in this study was that the response must correspond exactly with the stimulus. Therefore, an ad hoc statistical analysis of the Adjusted Errors was not made.

Grade level effect. The total numbers of errors made by the first, third, and fifth grade children were, respectively, 237, 117, and 91, as shown in Figure 2. Stated in terms of percentage of responses that were correct, the results were as follows: first grade--84.2 per cent; third grade--92.2 per cent; and fifth grade--93.9 per cent. The differences

between grade levels with respect to mean number of errors was statistically significant. As shown in Figure 2, comprehension increased from the first to the third grade, and from the third to the fifth grade, with the larger of these two differences being that between the first and the third grades.

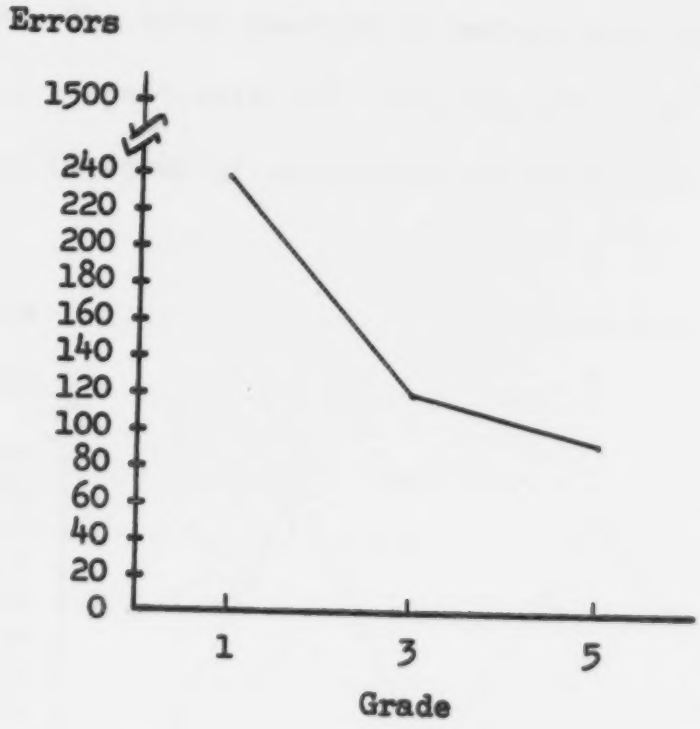

Figure 2. Performance as a Function of Grade Level

Intelligence classification effect. The total numbers of errors made by the average, superior, and very superior intelligence classifications were, respectively, 177, 135, and 133. Stated in terms of percentage of responses that were correct, the results were as follows: average--88.2 per cent; superior--91.0 per cent; and very superior--91.1 per cent. The differences between these classifications with respect to mean number of errors was not statistically significant. Thus, there was

no evidence that performance varied significantly among the three levels of intelligence.

Practice effects. It will be recalled that the 50 sentences were presented in five blocks of ten sentences each, with each words-per-minute rate being represented once in each block. This arrangement enabled a determination of whether subjects' performance improved over blocks of trials. The total numbers of errors made during practice blocks I through V were, respectively, 48, 132, 59, 126, and 80, as shown in Figure 3. Stated in terms of percentage of responses that were correct,

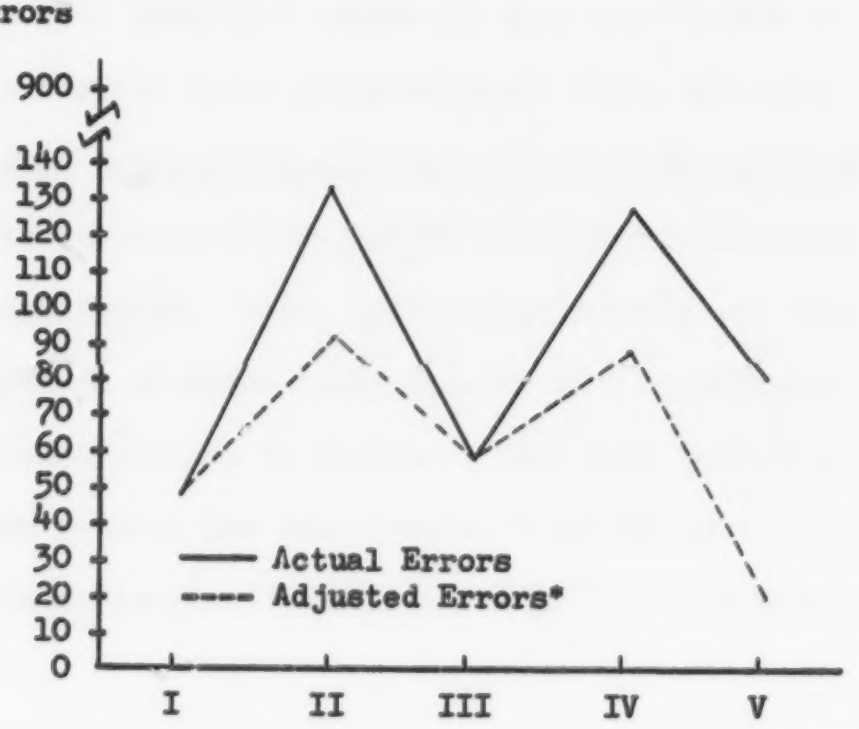

Figure 3. Performance as a Function of Practice

*See text for explanation of "Adjusted Errors."

the results were as follows: I--94.7 per cent; II--85.3 per cent; III--93.4 per cent; IV--86.0 per cent; and V--91.1 per cent. The differences

between the mean numbers of errors for the separate blocks were statistically significant. However, it can be seen in Figure 3 that these differences provide no evidence that performance improved with practice. The function in terms of Adjusted Errors is lowest at block V, but the reliability of this result cannot be ascertained.

Grade level by rate of presentation interaction effect. The interaction between grade level and rate of presentation was statistically significant. Thus, the differences between the mean number of errors as a function of rate of presentation varied significantly from one grade level to another. The nature of this interaction can be seen in Figure 4. Apparently, the most important aspect of this interaction is the steeper curve of errors for the first grade subjects above 250 wpm.

Grade level by intelligence classification interaction effect. The F for the interaction between grade level and intelligence classification was not significant. Thus, differences between the mean number of errors as a function of grade level did not vary significantly from one intelligence classification to another. This also indicated, of course, that differences between the mean number of errors as a function of intelligence classification did not vary significantly from one grade level to another.

Intelligence classification by rate of presentation interaction effect. The F for the interaction between intelligence classification and rate of presentation was not significant. Thus, differences between the mean number of errors as a function of intelligence classifications did not vary significantly from one rate of presentation to another. This also indicates, of course, that differences between the mean number

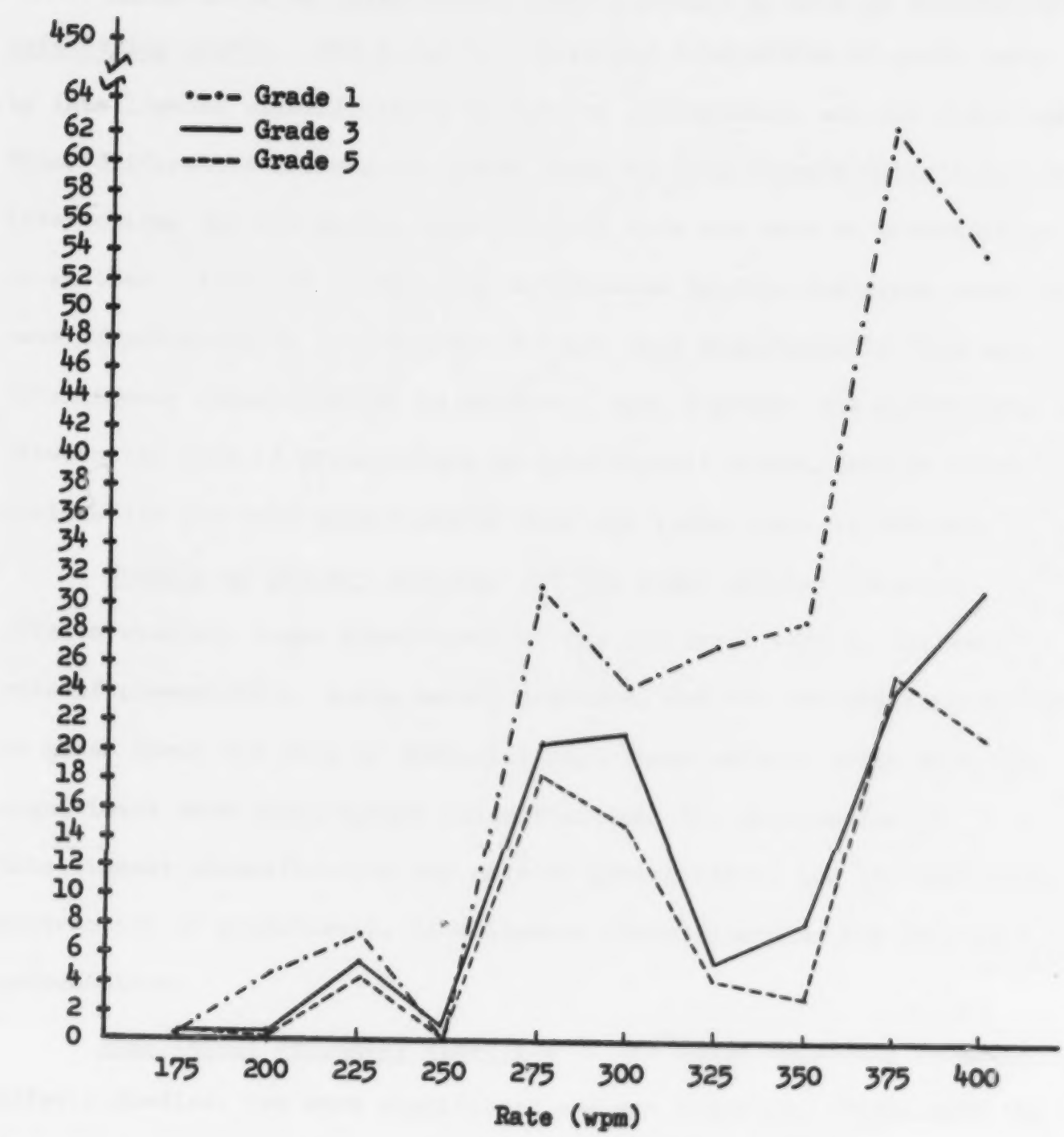

Figure 4. Performance as a Function of Rate of Presentation at Each of the Three Grade Levels

of errors as a function of rate of presentation did not vary significantly from one intelligence classification to another.

Grade level by intelligence classification by rate of presentation interaction effect. The F for the three-way interaction of grade level by intelligence classification by rate of presentation was not significant. Thus, differences between the grade level by intelligence classification interactions did not differ significantly from one rate of presentation to another. Also, of course, the differences between the grade level by rate of presentation interactions did not vary significantly from one intelligence classification to another. And, finally, the differences between the rate of presentation by intelligence classification interactions did not vary significantly from one grade level to another.

Summary of primary effects. Of the eight primary research effects studied, those significant at the .05 level were as follows: rate of presentation, grade level, practice, and the two-way interaction of grade level and rate of presentation. Those effects which were not significant were intelligence classification, the interaction of intelligence classification and rate of presentation, and the three-way interaction of grade level, intelligence classification, and rate of presentation.

Significant secondary effects. Of the seven secondary research effects studied, two were significant and are reported. These were the two-way interaction of rate of presentation by practice, and the three-way interaction of grade level, rate of presentation, and practice.

Rate of presentation by practice interaction effect. The interaction of rate of presentation and practice was statistically significant. Thus, differences between the mean number of errors as a function of rate of presentation varied significantly from one practice block to another. The nature of this interaction can be seen in Figure 5.

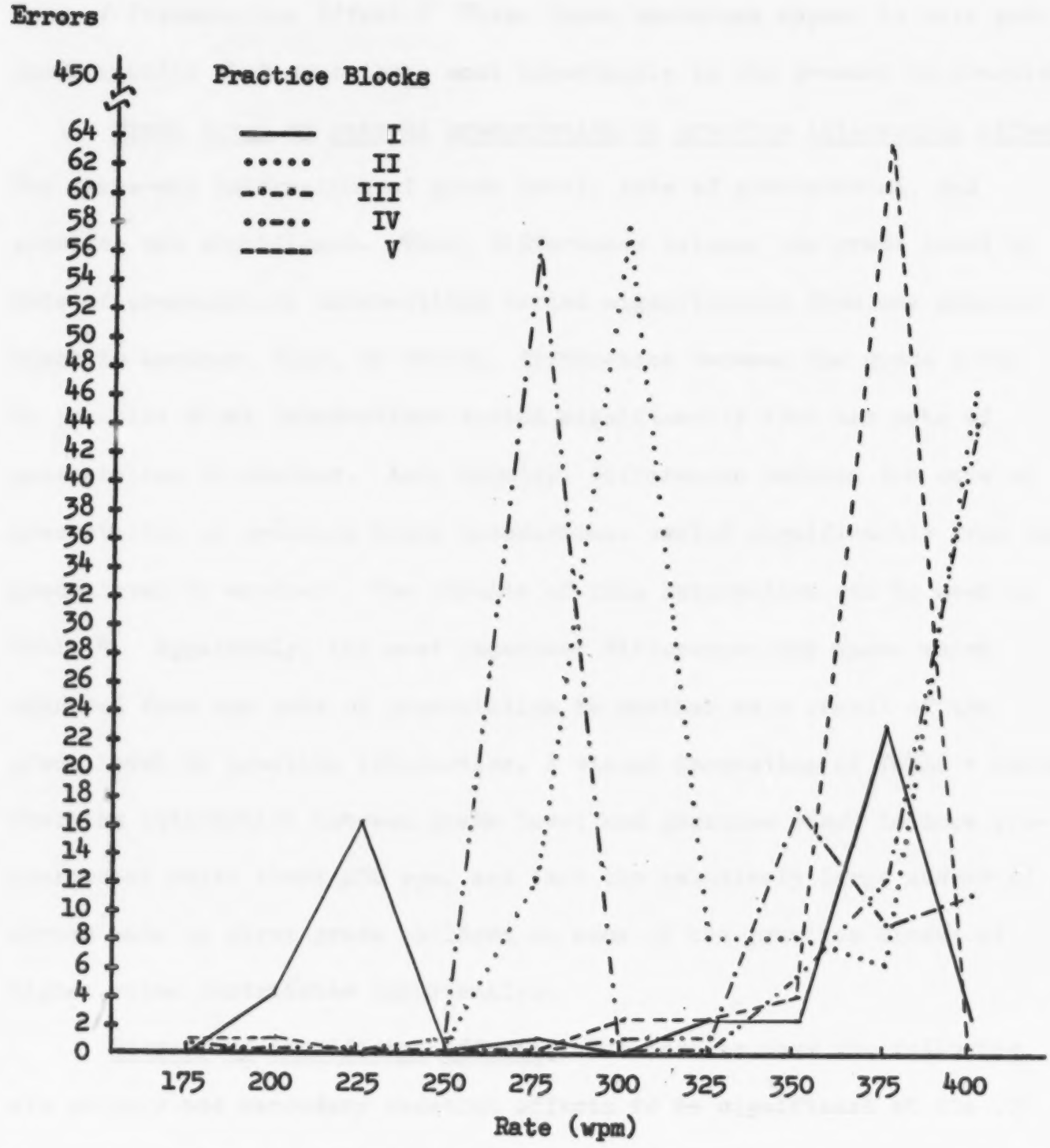

Figure 5. Performance as a Function of Rate of Presentation at Each of Five Practice Blocks

The three highest ordinate values in the graph can be accounted for on the basis of the three sentences discussed previously that were responded to incorrectly by an unusually large number of subjects. (See

Rate of Presentation Effect.) These three sentences appear to have produced results that contribute most importantly to the present interaction.

Grade level by rate of presentation by practice interaction effect. The three-way interaction of grade level, rate of presentation, and practice was significant. Thus, differences between the grade level by rate of presentation interactions varied significantly from one practice block to another. Also, of course, differences between the grade level by practice block interactions varied significantly from one rate of presentation to another. And, finally, differences between the rate of presentation by practice block interactions varied significantly from one grade level to another. The results of this interaction can be seen in Table 4. Apparently, the most important differences are those which occurred from one rate of presentation to another as a result of the grade level by practice interaction. A visual inspection of Table 4 shows that the interaction between grade level and practice block is more pronounced at rates above 250 wpm, and that the relatively large number of errors made by first grade children on some of the practice blocks at higher rates contributes importantly.

Summary of significant effects. The results show the following six primary and secondary research effects to be significant at the .05 level of significance: (a) rate of presentation; (b) grade level; (c) practice; (d) grade level by rate of presentation interaction; (e) rate of presentation by practice interaction; and (f) grade level by rate of presentation by practice interaction.

TABLE 4. TOTAL ERRORS FOR COMBINATIONS OF VALUES OF THE VARIABLES RATE, BLOCK, AND GRADE LEVEL

Sentence			Errors			
Rate	Order	Block	Grade 1	Grade 3	Grade 5	All grades
175	4	I	0*	0	0	0
175	12	II	0	1	0	1
175	23	III	0	0	0	0
175	35	IV	0	0	1	1
175	50	V	1	0	0	1
200	6	I	4	0	0	4
200	20	II	0	0	0	0
200	29	III	0	0	0	0
200	34	IV	0	0	0	0
200	42	V	0	1	0	1
225	2	I	7	5	4	16
225	18	II	0	0	0	0
225	28	III	0	0	0	0
225	31	IV	0	0	0	0
225	43	V	0	0	0	0
250	9	I	0	0	0	0
250	19	II	0	0	0	0
250	22	III	0	0	0	0
250	39	IV	0	1	0	1
250	47	V	0	0	0	0
275	8	I	1	0	0	1
275	13	II	7	4	1	12
275	24	III	0	0	0	0
275	38	IV	23 (3)‡	16 (4)	17 (1)	56 (3)
275	46	V	0	0	0	0

*Based on responses to 30 presentations at each grade.

‡Numbers in ( ) represent the rank order of the five sentences with the most errors.

TABLE 4 (Continued)

Sentence			Errors			
Rate	Order	Block	Grade 1	Grade 3	Grade 5	All grades
300	7	I	0	0	0	0
300	17	II	22 (4)	20 (1)	15 (3)	57 (2)
300	26	III	1	0	0	1
300	40	IV	0	0	0	0
300	48	V	1	1	0	2
325	10	I	2	0	0	2
325	14	II	5	2	1	8
325	21	III	12	3	2	17
325	36	IV	5	0	0	5
325	45	V	3	0	1	4
350	5	I	2	0	0	2
350	15	II	2	0	0	2
350	27	III	15	5	1	21
350	32	IV	4	1	2	7
350	44	V	6	2	0	8
375	1	I	14	3	4	21
375	11	II	4	0	2	6
375	25	III	7	1	1	9
375	37	IV	9	1	2	12
375	49	V	28 (1)	19 (2)	16 (2)	63 (1)
400	3	I	2	0	0	2
400	16	II	25 (2)	11 (5)	10 (4)	46 (4)
400	30	III	5	3	3	11
400	33	IV	19 (5)	17 (3)	8 (5)	44 (5)
400	41	V	1	0	0	1
Total			237	117	91	445

Discussion

Previous studies of the comprehension of compressed speech have suggested that an inverse relationship exists between comprehension and the words-per-minute rate of presentation. These studies have involved adults and older children as subjects. The results of the present study would seem to indicate that a similar inverse relationship exists in the comprehension of compressed speech by elementary school children.

Any more detailed discussion of the results should be prefaced by some qualifying remarks. First, the differences in stimulus material and test procedures between the present study and previous ones make direct comparisons of questionable validity. The comparability of the imperative sentences to which subjects made immediate overt responses, with the narrative readings and objective tests used in previous studies is very doubtful. However, it was felt that a comparison of some of the previous and present findings might contribute to a better understanding of the present results. Thus, an attempt is made to relate the findings of this study to previous ones.

Secondly, it appears possible that one of the major assumptions of the study may be questioned; namely, that all of the imperative sentences would be equal in inherent comprehensibility at any one of the rates used. Despite the lack of any evidence in the pilot studies that this assumption was not justifiable, it seems that some sentences may have varied considerably in inherent comprehensibility because of phonetic or other differences. For instance, sentences 17, 38, and 49--each at a different words-per-minute rate--appeared to be very difficult to

comprehend. Yet at the same rates, other sentences were comprehended with either no errors or relatively few errors. With this marked contrast so readily apparent, it is clear that other sentences also may have differed considerably in difficulty.

Although it is evident that some sentences varied considerably in inherent comprehensibility, nevertheless, the sentences as a group were comprehended quite well. Of the 4,500 responses to the sentences, 90.1 per cent were made correctly.

The present study did not result in a very orderly inverse relationship between comprehension and words-per-minute rate, such as was achieved by Foulke, et al. (15) and Fairbanks, et al. (10), but the change in comprehension as a function of rate was statistically significant. The general direction of the results was toward a decrease in comprehension with an increase in rate.

A significant relationship was demonstrated in this study between grade level and the extent of comprehension. The fifth and third grade children with 93.9 per cent and 92.2 per cent comprehension, respectively, were more than ten percentage points above the first graders with 84.2 per cent comprehension. Apparently, the important point to note here is that the extent of first graders' errors rose much more steeply than the other two grades at rates above 250 wpm.

There was no evidence in the present study that comprehension of compressed speech was related to intelligence classification. In part, this lack of relationship may have been due to the subjects' being composed only of students with I.Q. ratings of average and above, i.e., more competent students. In the broad sense of listening ability, less

competent students are supposed to be less capable listeners than those who are more intelligent (31:17). There was no opportunity in this study, however, to assess the comprehension of compressed speech by less competent students. Realizing that the restricted I.Q. range characteristic of the present study seriously limits comparability of results with other studies, it might be noted, however, that the results of this study would seem to be in conflict with Fairbanks and Kodmans' (8) conclusion that listener "aptitude" contributes to comprehension of compressed speech. On the other hand, the results would seem to support Fergen's (12) finding that intelligence was not a significant comprehension variable when children listened to verbal material that was spoken (not compressed) at a faster rate.

Although amount of practice was an experimental effect in this study, and the results indicated that it was statistically significant, the pattern of errors from practice blocks I through V was not an orderly one. Hence, although there were differences in comprehension by practice blocks, these differences did not seem to represent increases in learning due to increases in exposure. Rather, the indication seems to be that differences were dependent upon the difficulty of the sentences assigned to each block.

CHAPTER IV

SUMMARY AND CONCLUSIONS, AND RECOMMENDATIONS

Summary and Conclusions

An experiment was conducted to determine the effect of four variables on the extent of comprehension of compressed speech by elementary school children. The variables were rate of presentation of the verbal material, grade level in school, intelligence, and amount of practice.

Fifty tape-recorded short, imperative sentences served as the stimuli, five at each of ten words-per-minute rates, e.g., "Rub one of your elbows." The experimental task for each child, who was treated individually, was to listen to the fifty sentences by means of headphones, and, after each sentence, to make the overt response commanded by that sentence. Whenever the task was performed correctly, the sentence was judged by the experimenter to have been comprehended.

In preparing the sentences, each sentence was read aloud by a male narrator at a rate of approximately 175 words per minute, and was recorded on magnetic tape. Then the sentences were compressed to the desired experimental rates with a "speech compressor." This device electro-mechanically samples extremely small segments of a recording and discards every other one. The segments retained are reunited into a continuous, relatively undistorted, compressed unit. As the segments discarded are so short in length, no complete speech sound (phoneme) is lost. Compression results in an increase in the words-per-minute rate of presentation, and hence in a decrease in the presentation time.

The words-per-minute rates of presentation were as follows: 175, 200, 225, 250, 275, 300, 325, 350, 375, and 400 wpm. A practice block, of which there were five, consisted of ten sentences, one sentence at each rate. The assignment of sentences to rates and to blocks was randomized, as was the order of rates within blocks.

Ninety subjects participated in the experiment, thirty each at the first, third, and fifth grade levels. There were three intelligence classifications at each grade level with ten subjects in each: average (M = 98.8), superior (M = 116.6), and very superior (M = 132.9). At each grade level, subjects were selected randomly in equal numbers from the three intelligence classifications.

An analysis of variance showed the following effects to be statistically significant at the .05 level: rate of presentation, grade level, practice, the rate by grade level interaction, the rate by practice interaction, and the rate by grade level by practice interaction.

Generally, as the rate of presentation increased, comprehension decreased. Children exceeded a 90 per cent comprehension level at rates as high as 350 wpm, and at no rate was the level less than 75 per cent.

Fifth grade children comprehended more than third grade children, and third grade children comprehended more than first graders. In terms of percentages, comprehension at the three grade levels, respectively, was 93.9 per cent, 92.2 per cent, and 84.2 per cent.

In spite of the significance of the differences among practice blocks, there was not clear evidence of increased comprehension as a function of practice.

The rate by grade level interaction appeared to be due to the fact that for the first grade subjects, comprehension was considerably lower at rates above 250 wpm than it was for the third and fifth grade subjects.

The rate by practice interaction appeared to be due not to the relatively less importance of the rate variable as a result of practice, as might have been expected. Rather, the interaction appeared to be due to the fact that at the lower rates, comprehension was almost perfect regardless of the practice block, whereas at the higher rates, comprehension varied considerably from block to block. Since comprehension was not an orderly function of blocks, this variation seems likely to have been a function of marked differences in the inherent comprehensibility of the various sentences.

The rate by grade level by practice interaction appeared to be due to the fact that the rate by practice interaction just described was more marked for the first grade subjects than for the third and fifth grade subjects.

The effect of intelligence on comprehension was not statistically significant.

Finally, the indications of marked differences in inherent comprehensibility among the sentences, noted above, make it clear that experimental effects associated with rate and practice variables should be interpreted cautiously. Although the sentences were assigned randomly, their apparent heterogeneity in terms of difficulty may have either contributed to or obscured the relations between the rate and practice variables and comprehension.

Recommendations

In this study, listening comprehension was judged in terms of an overt response made to an imperative sentence. This seems to have been a practical technique to use with young children. It would also seem to be a practical technique to use with culturally deprived children, mentally retarded subjects, subjects with speech limitations, and blind subjects. However, as has been shown in this study, there is a need for imperative sentences that have been demonstrated to be comparable to each other in inherent comprehensibility. Thus, the development of such a list of sentences is suggested.

Although it was not found in this study that intelligence was a significant factor in the comprehension of compressed speech, the lower limit of the intelligence range of subjects was an I.Q. of 94. It is suggested that the effect of intelligence should be studied also at values below 94 I.Q.

The present study was limited to compressed speech composed of single sentences. It is not known to what extent young children might comprehend compressed speech in narrative form. This is suggested as an additional area of study.

The possibilities of increasing listening efficiency through the use of time-compressed recordings appear to be many. Questions such as the following might be worth exploring. What might be the effect on reading and listening rates if verbal material were presented to subjects simultaneously in printed and time-compressed recorded form? What might be the implications of time-compression for educational broadcasting?

It is suggested that there is a need for more laboratory and more developmental research in this field.

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APPENDIX

APPENDIX

Appendix A

Instructions to Subjects

You are going to listen to a tape recording of a man talking. He is going to talk to you at different speeds. Sometimes he may talk like this . . . (EXAMPLE PLAYED AT 175 WPM: "TAKE A LOOK AT THE CEILING."). Or he may talk faster like this . . . (EXAMPLE PLAYED AT 275 WPM: "TAKE A LOOK AT THE CEILING."). Or he may talk very fast like this . . . (EXAMPLE PLAYED AT 375 WPM: "TAKE A LOOK AT THE CEILING."). Sometimes you may understand him; sometimes you may not.

Did you hear the bell? It is a signal to you. It tells you to get ready to listen very carefully. You will hear it each time just before the man talks.

Every time he talks he will tell you to do something. When you understand what he tells you to do, show me that you understand by doing it quickly. Do it so I can see you doing it. If you don't understand what to do, wait quietly. When you aren't doing anything keep your hands in your lap. Do you have any questions? (QUESTIONS ANSWERED.)

We are going to practice now. Put on your headphones and listen carefully. (HELPED PUT ON HEADPHONES AS NEEDED.) Remember to do what the man tells you so that I can see you do it. (PRACTICE SENTENCE SEQUENCE PLAYED AS FOLLOWS: 375 WPM, "REACH TOWARD THE WALL"; 200 WPM, "CROSS YOUR ARMS IN FRONT OF YOU"; 275 WPM, "REACH TOWARD THE WALL"; 375 WPM, "LEAN FORWARD IN THE SEAT"; 300 WPM, "CROSS YOUR ARMS IN FRONT

OF YOU.")

Are you ready to go ahead? (FURTHER QUESTIONS ANSWERED AND THEN EXPERIMENTAL MATERIAL PLAYED.)

Appendix B

Stimulus Sentences

Practice block	Rate (wpm)	Order no.	Sentence
I	375	1	Buzz like a bee.
	225	2	Say your name out loud.
	400	3	Raise your hand.
	175	4	Hold your hands together.
	350	5	Hit the table with your fist.
	200	6	Try to cough a little.
	300	7	Close your eyes.
	275	8	Open your mouth very wide.
	250	9	Scratch your chin.
	325	10	Turn your head to one side.
II	375	11	Blow on your hand.
	175	12	Push against the table.
	275	13	Wag your head back and forth.
	325	14	Quack like a little duck.
	350	15	Nod your head up and down.
	400	16	Bump the table easily with your hand.
	300	17	Bite your finger easily.
	225	18	Clap your hands.
	250	19	Shut your eyes very tight.
	200	20	Place your hands over your eyes.
III	325	21	Point to the ceiling.
	250	22	Feel your teeth with your fingers.
	175	23	Cover your nose with one hand.
	275	24	Stick out your tongue.
	375	25	Look under the table.
	300	26	Shake your head from side to side.
	350	27	Bark like a dog.
	225	28	Touch both of your ears.
	200	29	Lift your arms up high.
	400	30	Tap the table with your fingers.
IV	225	31	Blink your eyes.
	350	32	Pound the table with a finger.
	400	33	Puff out your cheeks.
	200	34	Try to touch your foot.
	175	35	Put your hands on your head.
	325	36	Stamp your feet on the floor.
	375	37	Pretend you are drinking water.
	275	38	Kick your chair easily.
	250	39	Show me a big smile.
	300	40	Play like you are eating.

Practice block	Rate (wpm)	Order no.	Sentence
	400	41	Lay both hands on the table.
	200	42	Pull on your nose.
	225	43	Sit up very straight.
	350	44	Rub one of your elbows.
V	325	45	Count out loud to three.
	275	46	Draw a circle on the table with your finger.
	250	47	Touch your nose with a finger.
	300	48	Wiggle your fingers.
	375	49	Wave your hand over your head.
	175	50	Bend your elbow.